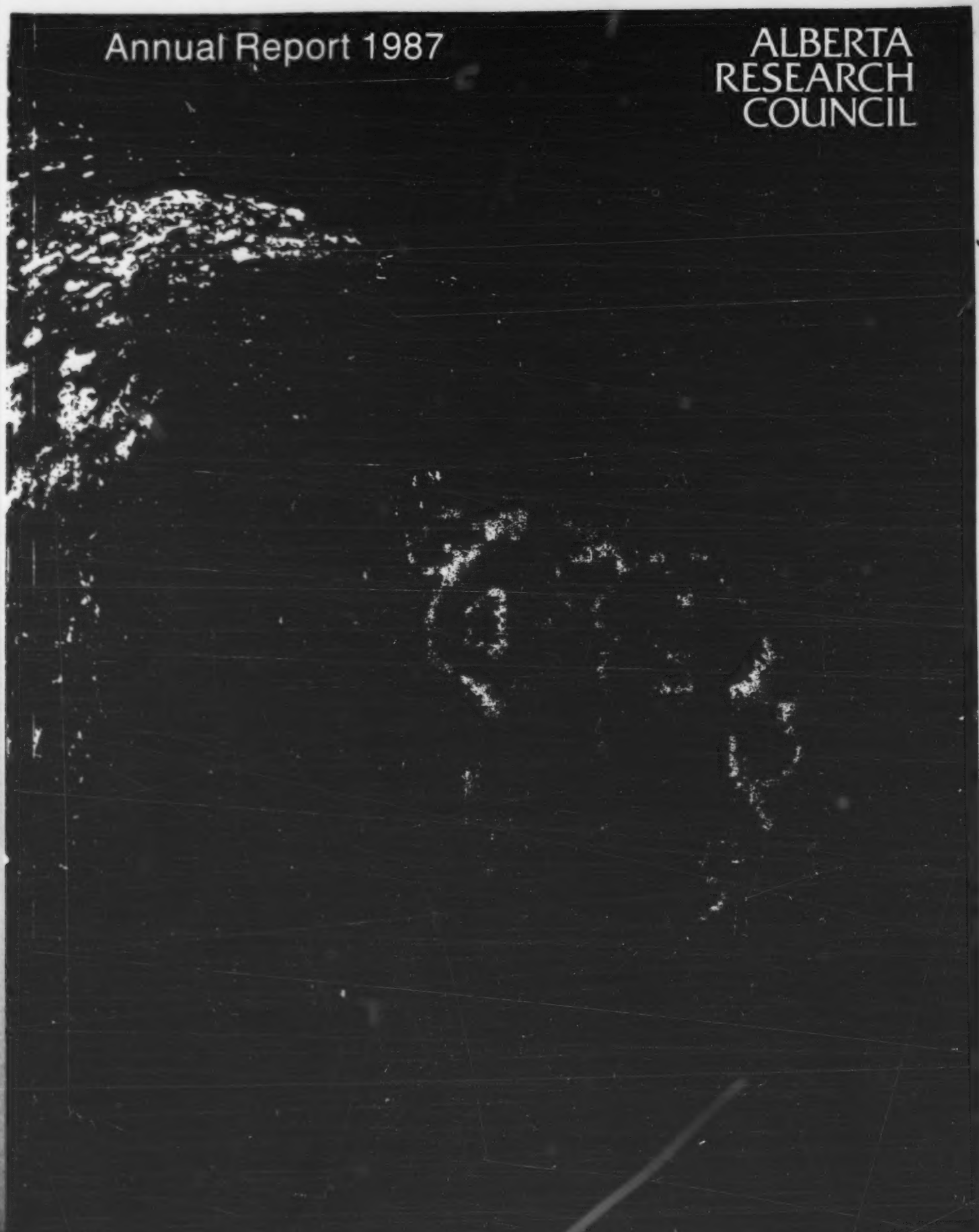
Annual Report 1987

ALBERTA RESEARCH COUNCIL



Corporate Profile

The Alberta Research Council is a crown corporation of the Province of Alberta, offering a diversified range of scientific, engineering and technological research and testing capabilities. The major research programs are:

Oil Sands and Hydrocarbon Recovery: Bitumen recovery processes by steam and/or additive injection in the Athabasca and Cold Lake oil sands; geological and hydrogeological investigations at Athabasca, Cold Lake and Peace River; numerical modelling; maintenance of an oil sands sample bank.

Coal and Hydrocarbon Processing: Coal utilization research including agglomeration, gasification, combustion, co-processing; hydrocarbon upgrading; coal geology; classification and evaluation of Alberta coals by pyrolysis and petrography.

Natural Resources: Geological studies and mapping; terrain sciences, concentrating on management of soil and water resources; geographic information systems; land reclamation for use after surface mining; mathematical modelling of fluid flow in deep sedimentary basins; civil engineering in transportation and rivers; environmental sensing and modelling.

Biotechnology: Microbiology, fermentation technology and pilot level scale up; plant cell culture; genetic engineering in the development of pharmaceuticals.

Industrial Technologies: Research and testing laboratories for gasoline and oil, materials and industrial chemicals testing and analysis. Forest products development and testing of panel products using Alberta forest resources.

Advanced Technologies: Computer-based technologies including automation, expert systems and robotics for application and transfer to industry.

Service to Industry: Providing short-term advisory and technical service to Alberta companies; administration of the National Research Council's Industrial Research Assistance Program (IRAP) for Alberta industry.

The Electronics Test Centre provides testing and evaluation services to electronic and telecommunications products manufacturers requiring product certification, and provides companies with engineering assistance in planning and developing new products.

The Alberta Research Council operates five specialized information centres in industrial information, electronic industry information, oil sands, geology and waste exchange.

Cover: A CT scanner produces cross sectional view of an oil sands core allowing scientists to track fluid distribution. In this composite photo the image has been superimposed on a photo of a core sample. *(See page 26)*

Photo: L. Lorinczi

The Alberta Research Council is a member of the Association of Provincial Research Organizations (APRO).

Letter of Transmittal

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To The Honorable Les Young
Minister of Technology, Research & Telecommunications

In accordance with the requirements of the Alberta Research Council Act, I have the honor to present to you the Annual Report of the Alberta Research Council for the calendar year 1987.

Respectfully submitted,

Fred Bradley

Fred D. Bradley, M.L.A.
Chairman of the Board
Alberta Research Council

March 1988

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Chairman's Message

Throughout its long history, the Alberta Research Council has been singularly fortunate in the calibre of men who have guided its progress. Our new president, Dr. Clem W. Bowman, is no exception. Nor is he a stranger to many of us, having served on the Board of Directors since 1978. Dr. Bowman has had a distinguished career in industrial research with major oil and chemical companies and was founding chairman of the Alberta Oil Sands Technology and Research Authority (AOSTRA), which he served as chief executive officer from 1975 to 1984. As a long time proponent of industry/university/government cooperation, he is giving new impetus to the Research Council's efforts to become more closely involved with industry.

Dr. Robert W. Stewart, who retired in June after three years as president, has left a legacy which will endure far into the future. With the establishment of a Calgary presence, Dr. Stewart turned an essentially Edmonton operation into a truly province-wide organization. His decision to form the Advanced Technologies Department stands as a tribute to his vision for the future.

I also would like to acknowledge Dr. Stewart's resolve in providing steadfast leadership during the difficult period of reductions to staff and programs, a result of the government's general policy of downsizing, brought about as the province faced a shortfall in revenue caused by the disastrous fall in world oil prices.

The Alberta Research Council, the first publicly funded provincial research agency, is one of the strands woven into the very fabric of our provincial economy. Indeed, it would be very difficult to envision an Alberta in which the Alberta Research Council did not play a pivotal role. Its work is relevant and practical and is geared in large measure to giving Alberta industry the kind of technological edge it needs to thrive in a highly competitive marketplace. The major activities in biotechnology, in energy and forestry, and in advanced technologies are vital to the advancement of our economy and the quality of life in Alberta. The services to industry and the success of such programs as the joint research ventures are opening doors of opportunity in product development for Alberta entrepreneurs in many sectors.

Increasingly responsive to the needs of industry, the Research Council is encouraging companies, large and small, to access its remarkable scientific resource. Although this emphasis on using science to strengthen and develop the economy is being stressed more now than at any time in Research Council history, it is not a new philosophy. In fact, it was part of the

organization's original mandate and will continue to be the theme in the coming years.

We had one change to our Board of Directors this year. Dr. Gordin Kaplan, who had served as the University of Alberta representative since 1984, retired in June. On behalf of the board and staff, I thank him for his leadership and commitment. Dr. Kaplan, a renowned biochemist, lecturer and researcher throughout Canada, the United States and Europe, has achieved distinction not only through his many scientific publications, but also as a leader in his field and the community at large.

We welcome to the Board of Directors Dr. C. Robert James, vice-president (research) and professor of electrical engineering, University of Alberta, who was appointed for a three-year term.

Another of our board members, Roy O. Lindseth, Calgary, president of Teknica Resource Development Ltd., was elected a Fellow of the Academy of Science of the Royal Society of Canada. Mr. Lindseth was one of 50 distinguished Canadian humanists and scientists to be inducted into the Society last spring.

The scope and diversity of the Alberta Research Council is reflected in this annual report. On behalf of the board, I express my appreciation to the employees of the Alberta Research Council who provide the creativity and hard work so necessary to meet the challenges of change.

Fred Bradley

Fred D. Bradley, M.L.A.
Chairman of the Board

President's Report

Robert Newton, Nathaniel Grace, Ernest Wiggins, Gilles Cloutier, Robert Stewart: the five previous presidents of the Alberta Research Council have, over nearly four decades, created a remarkable organization. In no other province is the provincial research organization so uniquely positioned to work with the private sector, government and the universities in supporting the economy.

In this, my first year with the Research Council, I have been impressed with the breadth of the organization's capability in both the traditional resource industries—coal, oil sands, forest products—and in the new high technologies—microelectronics, biotechnology, computing, expert systems. It is not only the unique facilities which set the Alberta Research Council apart; it is the quality and dedication of our staff who understand the Alberta 'vision', and are striving to make it happen.

Our joint research venture program with small- to medium-size companies has been highly successful in technology transfer and in developing marketable products. Since its inception in 1983, six joint research venture projects with private industry have been completed and another five are currently in operation, representing a total investment by both the Research Council and the venture partners of more than $16 million.

The Alberta Research Council has forged a link with one of its sister provincial research organizations in signing an agreement with the Saskatchewan Research Council. The agreement establishes the framework to make optimal use of our respective resources in providing services to industries and governments of both provinces.

The Alberta Research Council has ten research departments, each focused on a different aspect of Alberta's economy. Each department has its own set of clients and its own particular mission to perform. The departments have undertaken the necessary restructuring to meet budget restraints and to address new initiatives. Highlights of their work are shown on the next page of this report.

A word on senior management. The downsizing of the staff and the trend to a decentralized operation led us to decrease the number of vice-presidents from six to four. All of the operational support functions have been brought together under the vice-president, Operations. The energy and biotechnology portfolios, involving pilot plant scale up activities, are under one vice-president, as are all of the industrially-related programs both in Edmonton and Calgary. The natural resource sciences, including the Geological Survey, report to the fourth vice-president. The corporate secretary and director of public relations,

together with the president and four vice-presidents, makes up the senior management team.

This report documents some of the 1987 accomplishments which have contributed to Alberta's economy. There are many new challenges for 1988. Members of the Board of Directors and staff of the Research Council are evaluating ten specific initiatives for possible inclusion in our 1988 program. These include new ventures in biotechnology, in land-related information systems, and participation in Canada's Space Program.

International competition will be keen; but the combination of our high technology expertise and our natural resources puts us in a strong starting position.

The opportunity to be part of the Alberta Research Council team is a great honor for me, and I am very pleased to be back in Alberta.

Clem Bowman

Clem W. Bowman
President

Highlights

Oil Sands and Hydrocarbon Recovery: Research programs reoriented to meet industry-identified requirements. Novel processes developed for reservoir communication control, solvent dispersion and horizontal injection and submitted as invention disclosures.

Coal and Hydrocarbon Processing: A $4.5 million agglomeration project, using low rank coals with heavy oil and bitumen, initiated with the Electric Power Research Institute in Palo Alto, California. The project has attracted participation of 18 private sector resource and utility companies and government agencies.

Biotechnology: Construction of a 15 000-litre fermentor and downstream support system undertaken which will expand pilot plant fermentation capacity to more than 20 000 litres. The Alberta Research Council enters space research in a cooperative biotechnology project with the National Research Council and a Saskatchewan aerospace engineering company.

Industrial Technologies: A $1.25 million contract signed with Esso Resources Canada Limited to find a solution to rejuventating petroleum pipelines. Gasoline and Oil Testing Laboratory receives accrediation from the Standards Council of Canada.

Geological Survey: A five-year project is under way to produce a new Geological Atlas of the Western Canada Sedimentary Basin containing the latest ideas in plate tectonics, basin architecture and the evolution of petroleum hydrocarbons.

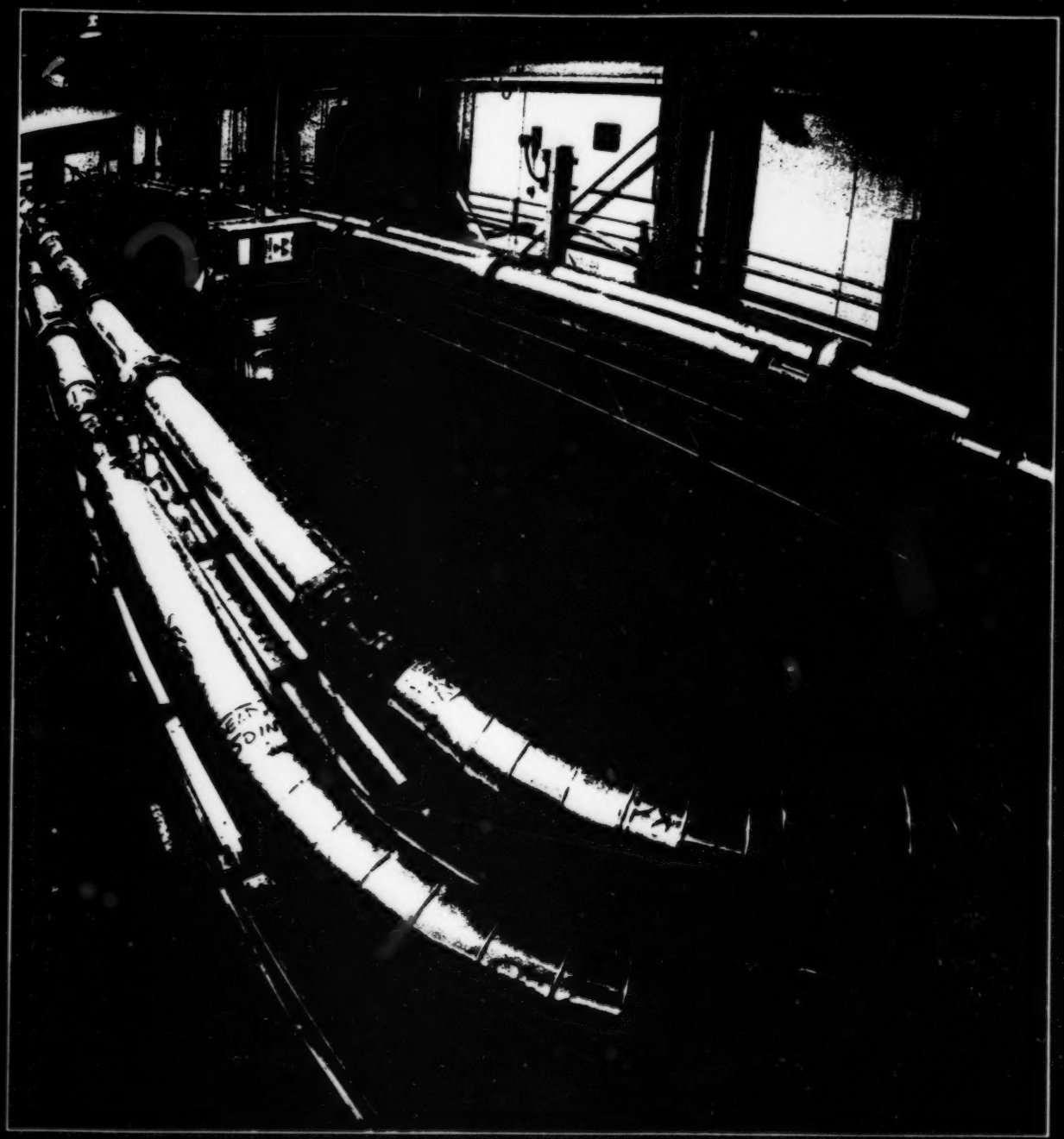
Resource Technologies: A severe weather forecasting expert system, developed by the Alberta Research Council, is integrated with an artificial intelligence system for weather analysis developed by MacDonald, Dettwiler and Associates Ltd., Richmond, B.C.

Terrain Sciences: Leaders in Alberta in applying Geographic Information Systems (GIS) to land management and evaluation. An evaluation system of recreational land, developed for Forestry, Lands and Wildlife, opens up opportunities for private sector consultants working on the project.

Advanced Technologies: A two-year $1 million agreement signed with International Artificial Intelligence Corporation, Toronto, Canada's leading private company in commercialization of products and services in artificial intelligence. The Alberta Research Council also is a founding member of PRECARN Associates Ltd., a national consortium formed in 1987 to promote and conduct research in artificial intelligence and robotics.

Industrial Development: More than $3.5 million dispensed to Alberta companies under the National Research Council's IRAP (Industrial Research Assistance Program) funding.

Electronics Test Centre: Obtained formal accreditation from the Department of National Defence which will allow western companies to make more competitive bids for DND work.



The 100-metre pipe loop facility in the Oil Sands and Hydrocarbon Recovery laboratories, Clover Bar, used for studying multi-phase flow of cruce oil at high pressure and high temperature.

Energy

Oil Sands and Hydrocarbon Recovery

The petroleum industry requires a greater mechanistic understanding of fundamental oil recovery and flow processes in the reservoir and increased research on production related problems associated with the operation of current field pilots for in situ recovery of oil. Many companies, forced to reduce their own effort in research, have recognized a need for the Alberta Research Council to act as their research arm which has resulted in a reorientation of research programs to meet industry-identified requirements. The Alberta Research Council and the Alberta Oil Sands Technology and Research Authority (AOSTRA) equally fund a Core Program under which the Research Council focuses on generic problems, evaluates and verifies novel concepts, investigates fundamental reservoir mechanisms and supports long-term technology development. The Research Council makes information from this work available to members of the Industry Access Program sponsored with AOSTRA.

This year, under the Core Program, the Research Council and AOSTRA have set up technical committees, with representation from the Industry Access Program members, to provide direction and increased interaction with industry. To facilitate the transfer of Research Council technology to field applications, Research Council engineers were seconded to AOSTRA field pilot projects operated by the partner oil companies.

The Alberta Research Council continued its emphasis on the study of steam-based processes for in situ recovery of oil from heavy oil and oil sands deposits in Alberta. Under the Core Program scientists investigated the fundamental reservoir mechanisms needed in developing and evaluating novel concepts for recovery of oil from bitumen deposits. Conditions leading to the mobilization and transport of fine solids in the reservoir and the use of foams to increase recovery were determined experimentally. Based on these experiments, advanced models for predicting foam transport, fines transport and geochemical changes in the reservoir were developed.

The AOSTRA/Alberta Research Council Strategic Program, funded by AOSTRA, continued as a directed program of research in support of specific field pilot projects. Problems relating to multiphase flow behavior and the control of solids in horizontal wells used for bitumen recovery were studied in the Research Council's new experimental apparatus. Novel processes were developed for communication control, solvent dispersion and horizontal injection, and these were submitted by AOSTRA as invention disclosures.

Many Alberta oil reservoirs overlie active water zones where groundwater flows occur. In these reservoirs, a phenomenon referred to as "water coning" can occur around a production well, resulting in increased water production and reduced oil production. Using numerical simulation models and partially scaled physical models, methodology was developed to understand the mechanisms which will delay, reverse or suppress water coning at the production well. A process, presently being patented, was demonstrated on the unique 150 cm test cell, showing that water coning can be suppressed.

Increased national and international recognition of the Research Council's capabilities has resulted in several opportunities for the possible application of Alberta technology outside of Alberta and outside of Canada. In 1987, Research Council scientists and engineers participated in research projects in cooperation with companies, governments and individual scientists in Saskatchewan, the United States, United Kingdom, Indonesia, China, France and Japan.

The Indonesian government requires expertise to help develop its rock asphalt deposits as a source of construction materials in a major highway development program. Contact with the Alberta Research Council has led to the placement of Alberta consultants in Indonesia to assist with the

project. Two Alberta Research Council scientists were also invited by the Indonesian government as specialists to assist in formulating a long-term program for exploitation of the deposit.

Cooperative research programs between AOSTRA, the Alberta Research Council and the People's Republic of China were put in place in 1987. Two visitors from the Research Institute of Petroleum Recovery (RIPED) in Beijing spent up to six months in Research Council laboratories. A Research Council scientist then visited RIPED for six weeks and assisted with the design of a foam test for field application in oil recovery from one of China's heavy oil reservoirs and lectured on Research Council oil sands work.

Anna Truong prepares sample of distillate for rotary evaporator at Coal Research Centre, Devon.

Staff were invited to help the United Nations Institute for Research and Training (UNITAR) in its effort to establish an international working group on Laboratory Standards for Characterizing Heavy Crude and Tar Sands. An international collaborative analytical study was organized using heavy crude samples from Canada, Indonesia, Venezuela and the United States.

International activities were not restricted to government-sponsored projects. The Research Council's contract on formation damage effects in heavy oil recovery with Atlantic Richfield Company of Dallas, Texas continued in 1987. Contract negotiations with Mobil Oil Corporation for a joint research program on effects of steam flooding in its California operation has resulted in staff visiting the Bel Ridge plant to develop a longer-term research program, part of which will be completed at the Alberta Research Council.

The Alberta Research Council, CANMET and the Saskatchewan Research Council, under a US-Canada Memorandum of Understanding, conducted studies which revealed considerable useful information on the chemical and physical property changes occurring in oil during in situ thermal recovery processes. Similar studies were started with petroleum companies to examine their field projects and the often unique conditions they encounter in the reservoir.

Texaco Canada Resources, a long-standing industrial client, though reducing its overall research budget, continued to fund research in bitumen recovery, placing more emphasis on enhanced recovery of conventional oil and studies of solids control. This is pioneering work on solids control for thermorecovery wells, oriented toward the development and improvement of solids control filters.

Many projects involve consortia of two or more companies. One such project involves Petro-Canada, Mitsubishi Canada Limited, and the Alberta Research Council. In a field consisting of many production wells, there are significant differences in the fluids composition from each well. To monitor these individual differences, a fast, robust flow

meter which yields both flow rate and fluid composition is needed. Together with Petro-Canada and Mitsubishi staff, an extensive series of tests were performed at a Petro-Canada oil production field using a fluid composition meter developed by Mitsubishi. The equipment was then installed on the 100-metre pipe loop facility at the Alberta Research Council for further measurements and calibration under more controlled laboratory conditions.

A joint research project is in progress with Western Geophysical Company of Canada Ltd., Calgary, to develop field instrumentation for monitoring the movement of miscible fluid fronts in enhanced oil recovery applications.

In a project jointly funded by Syncrude Canada Ltd., CANMET and the Research Council, studies are being conducted on the tailings sludge produced by the hot water extraction process used by Syncrude and Suncor Inc. in surface mining of bitumen. The purpose is to find an effective, economic way to return the clay and water mixture safely to the environment. In cooperation with the United States Geological Survey, Research Council scientists spent time in California, developing computer modelling programs for properties of oil field brines.

The Oil Sands Sample Bank, funded by AOSTRA, provided samples from pilot and commercial operations in Alberta and Saskatchewan to industry and university researchers for their studies in process development and evaluation. The Sample Bank also organizes exchanges with commercial laboratories and research establishments in which Alberta oil sands samples are supplied for evaluating analytical techniques.

Coal and Hydrocarbon Processing

A research project involving testing of agglomeration of low rank coals with heavy oil and bitumen has important economic and environmental implications for those involved in all facets of the coal industry including production, cleaning, transportation and use. A $4.5 million project, undertaken by the Alberta Research Council and the Electric Power Research Institute in Palo Alto, California, has attracted the participation of 18 private sector resource and utility companies and government agencies in Canada and the United States. Initial tests show that the process removes between 50 percent and 90 percent of mineral matter, depending on the type of coal and process conditions, and results in almost 100 percent recovery of coal and heavy oil. The thermal treatment of agglomerates, made with a 45 percent distillable heavy oil, produces oil which is 70 to 75 percent distillable. The agglomerates form a clean, dry, low-dust product suitable for transportation, and the distillate oil yield is a bonus. The upgrading potential for both poor quality coals and poor quality oils is of particular interest in Alberta where there are large reserves of low rank coal, heavy oil and bitumen.

Co-processing of coal and bitumen, to improve the process, reduce capital costs and to determine the economic advantage of obtaining liquid fuels from coal, is the focus of studies being conducted at the Alberta Research Council. Scientists also want to provide further data showing that co-processing is economically viable in comparison to heavy oil and bitumen upgrading. With funding from Canadian Energy Development Inc. (formerly CCLC Technologies Inc.) and the Alberta Office of Coal Research and Technology, the Research Council is currently evaluating the Pyrosol coal liquefaction process using Alberta coals and bitumen. Under a five-year contract signed in 1987, work is under way to extend the current data base with different coal and bitumen pairs. A 10-Kg/h process development unit, to further demonstrate the process concept, has been contructed at the Research Council's Nisku High Pressure Facility. The basic engineering data, obtained on reactor dynamics, and process sensitivities to temperature, pressure and feed rates, are used by the client to carry out scale up and conceptual design evaluations.

In support of the Canadian Energy Development Inc. studies, analytical procedures for characterizing coal liquid products relative to refinery specifications were put in place. Secondary upgrading experiments were performed on coal co-processing products in order to meet refinery specifications for synthetic crude. In a joint program with the University of Alberta, a carbon isotope technique was developed, which has received international notice. It enables discrimination of components in the liquid products of coal-bitumen co-processing reactions.

Two projects to study the hydrodynamics of high pressure slurry reactors under hydroprocessing conditions will provide valuable information to assist researchers in evaluating the performance of reactors over a range of variables. Scientists are evaluating the bubble behavior and the mixing pattern in a three-phase slurry reactor used for coal and bitumen co-processing. A laser/fibre optical technique is being used to study the bubbling phenomena in high temperature, high pressure reactors. A related study, jointly funded by the Alberta Research Council and AOSTRA under the Strategic Program, is being carried out to investigate the hydrodynamics of a bitumen hydrocracker. Reactive tracers are injected to determine the degree of backmixing in the vapor and liquid phases. With the acquired hydrodynamic information and the reaction kinetic data, mathematical models can be developed to describe and predict the performance of hydroprocessing reactors. The knowledge and models assist process design groups and evaluation engineers to understand the benefits and limitations of specific equipment and process designs for scale up and commercial studies.

In response to growing industry interest in gasification technologies, a major new initiative was funded by the Alberta Office of Coal Research and Technology to provide detailed technical support, develop trained staff and set up laboratory-scale facilities for the study of gasification properties of Alberta coals. Under the guidance of a joint industry/government gasification technical committee in which the Research Council is an active participant, fluidized bed gasification experiments on three Alberta coals were performed at the University of British Columbia to obtain engineering performance measurements of specific commercially viable coals for a particular gasification technology.

Combustion experiments were performed to examine physical changes of coal particles during combustion and their relationship to combustion reactivity. Numerical modelling data from such chemical reactions contribute to the understanding of single particle combustion. Combustion properties of blended coals and upgraded coal were studied to assist in the commercial evaluation of coal treatments which may help increase industrial thermal coal market development.

Fort Saskatchewan Engineering Ltd. approached the Research Council with a concept for a novel proprietary process to make ethylene amines, reagents used as chemical feedstocks in agricultural, pharmaceutical, mining, road surfacing and other processes. At the request of the company, Research Council chemists completed feasibility and chemical studies which proved the process was viable at the batch laboratory-scale. This work was followed by a further contract to conduct continuous pilot reactor studies and a demonstration of the technology for potential overseas purchasers. The technology has been returned to the client for long-term pilot reactor studies and the Research Council continues to advise the client.

Economical processes for the production of higher hydrocarbons directly from methane, the largest component of natural gas, have long been sought. In experiments elsewhere, researchers have demonstrated that ethylene and ethane from methane can be produced using catalytic systems. In an effort to exploit the merits of these systems, Research Council scientists investigated the oxidative coupling of methane on low-melting metals, using different catalyst supports and nitrous oxide as the principal oxidant. Promising results of this work will contribute to the basic chemical understanding

necessary in developing technologies for transforming natural gas into liquid fuels.

Coal Mining

The economic viability of plains coal exploration and mine planning can be greatly improved by coordinating information on geotechnical, stratigraphic and groundwater conditions prior to mining. Under jointly funded Surface Geophysics and Downhole Geophysics projects, Research Council scientists worked with coal producers, geotechnical companies, the Alberta Office of Coal Research and Technology and CANMET. In 1987, the final draft report on geophysics techniques for detecting and characterizing shallow surface coal seams was completed and many participants have adopted recommendations from this report. In the Downhole Geophysics project, a literature search was completed and geotechnical and groundwater data sets assembled for correlation with geophysical logs.

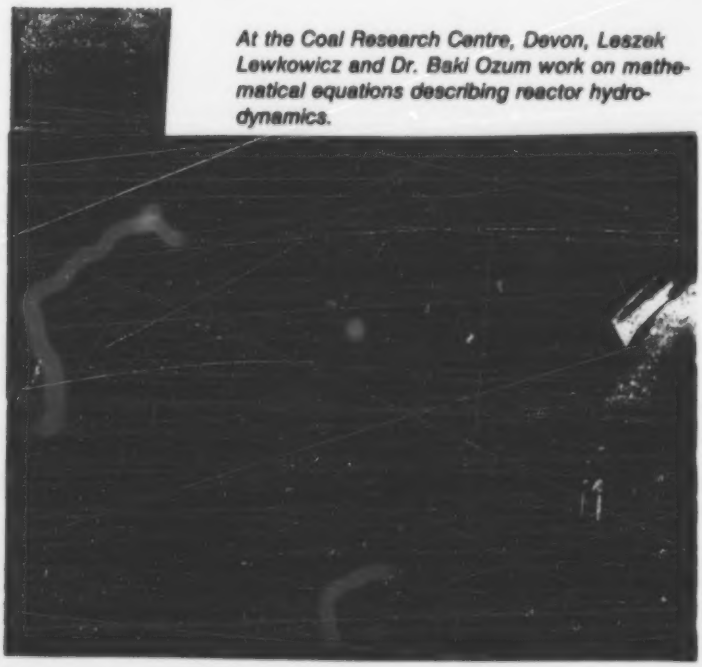
Staff also assisted Fording Coal Limited at the Genesee drilling site by providing advice on techniques for detecting glacially deformed bedrock.

Hydrocarbon Upgrading

In April 1987, AOSTRA and the Alberta Research Council began the second three-year phase of a joint research program in upgrading of bitumen, residue and pitch to useful products. The first project, Pitch Conversion, is providing encouraging results from tests of homogeneous catalysts for hydroprocessing of bitumen. Catalysts, developed by AOSTRA's University Research Program, are mixed with bitumen and hydrogen in autoclaves or simple tubular reactors at high temperatures and pressures. With the aid of computer generated models, scientists interpret the results of these tests and others that determine the dynamics, and are able to evaluate the novel processes and predict their performances in larger, perhaps commercial, reactors.

Most of Alberta's synthetic crude is produced using specially designed coking reactors. Coke often forms at unwanted locations in non-coking units important to the operation of an upgrader or refinery. In a second project, Mechanisms of Coke Formation, researchers are obtaining an accurate description of how residues of bitumen thermally degrade to form coke. Flow of the fluids over various surfaces, some heated, is studied to determine parameters important to the design of cokers and other hydroprocessing equipment.

Scientists also are testing newly-reported novel processes that promise hydrotreating of bitumen fractions at much lower temperatures and pressures than are used conventionally. These bench-scale experiments are of a fundamental nature but are inventive, revealing processes which may be tested further in the larger reactors of the first project.



At the Coal Research Centre, Devon, Leszek Lewkowicz and Dr. Baki Ozum work on mathematical equations describing reactor hydrodynamics.

Doug Boisvert, Geological Survey, examines a sample of Alberta quartz containing vein gold.

Energy Resources Geology

The formation of oil sands deposits, the existence of rivers and estuaries, tidal influences and other environmental conditions at the time of deposition, are determining factors in the future exploitation of oil sands deposits. Under a joint project with AOSTRA and Alberta Energy, the Alberta Research Council is documenting the hydrocarbon distribution in the McMurray Formation to establish the subsurface variation. In Athabasca Central, geologists have identified and mapped three different types of sand bodies and their variations, which will influence eventual recovery processes. Much of this information was processed as sophisticated digitized data with the cooperation of D & S Petroleum Consulting Group, Calgary.

In portions of the Bodo pool, in eastern Alberta, rich reservoir horizons are interrupted by shale fragments. A multidisciplinary group is developing a method for predicting the effects of these shale fragments on oil recovery. These models will have applications to other types of geological structures.

With AOSTRA funding, the Alberta Research Council provides geologic expertise in support of AOSTRA pilot projects undertaken as cooperative ventures with private industry. This year, the Alberta Research Council provided major assistance for AOSTRA's Underground Test Facility at Fort McMurray, where steam will be injected into the oil sands from tunnels excavated in the carbonate rock underlying the oil sands deposit.

In coal mine planning and export marketing, it is imperative to have detailed knowledge of the characteristics of Alberta coals. An overview delineation study of coal resources by the Alberta Research Council has been used to focus research on coal quality. The Alberta Research Council has worked closely with the Energy Resources Conservation Board in developing a data base system which supports all the coal geology research in the province. The coal industry cooperated by sharing data. This data base system marks the Alberta Geological Survey's entry into the Geographic Information Systems (GIS) field and will be available (excluding information covered by confidentiality agreements) to the coal industry at large.

The Peace River area is one of the most highly prospective in the Western Canada Sedimentary Basin. Advancement of understanding of the Peace River Arch's geological features has enormous economic implications for future oil and gas exploration. The Alberta Research Council is collaborating with the Institute of Sedimentary and Petroleum Geology (ISPG) in investigations into the origin and geological history of the Peace River Arch. The sedimentation, fluid flow, geothermal regime, and oil and gas distribution in northwestern Alberta and northeastern British Columbia are included in the three-year study.

When oil companies determine drilling strategies, one of the important considerations is the potential for blowouts. Under ISPG funding, Alberta Research Council geologists are analyzing the relationship between regional occurrences of anomalously high pore pressures and the hydrogeological and geothermal regimes in the Beaufort/Mackenzie regions.

The Geological History of Western Canada, a landmark publication issued in 1964 by the Canadian Society of Petroleum Geologists, is now seriously out of date. Work began this year on a five-year project to update the atlas, incorporating the latest ideas on basin architecture, plate tectonics, thermal/organic maturation and the evolution of petroleum hydrocarbons in the Western Canada Sedimentary Basin. The Alberta Research Council is responsible for managing the project and generating the computer maps for various contributors. The Research Council, Alberta Energy and the Canadian Society of Petroleum Geologists have committed direct funding; digital data are being provided by the four western provinces; and volunteer manpower has been committed by oil companies, geological surveys and the Universities of Alberta, Calgary and Saskatchewan.

Forest Products

Forest Products Research

The goal of the Research Council's forest products program, now in its seventh year, is research, development and testing to increase and improve the commercial utilization of Alberta's forest resources. The best opportunities for upgrading the province's low-diameter aspen stands lie in their use as engineered wood composites, particularly as structural materials.

Completion of the panel development laboratory in 1986 provided Alberta industry with a unique capability to design and produce new types of panels using different feedstocks, and to improve panels now in commercial production.

Commercial activity within the laboratory has grown significantly and several types and sizes of experimental prototype panels were produced. The main thrust of this work was in the reduction of the quantity of resins used as binders in experiments with new types of resins, and in the introduction of mixed wood species in strandboard manufacturing. Some panels were successfully produced using feedstock materials derived from agricultural waste.

Work continued in laboratory production of "waveboard", a corrugated board developed at the Alberta Research Council and which is seen as a possible replacement for many building systems including stud walls, conventional floors and light industrial roofs. Improvements were made in the quality and consistency of prototype production and an effort is under way to encourage industry to commercialize the technology. A "memorandum of licensing opportunity" was prepared, and to increase awareness of "waveboard" among potential users, samples of "waveboard" and innovative products were displayed at an international conference on structural wood composites in Memphis, Tennessee, and at the Alberta engineering centennial, Voyage of Discovery, in Edmonton and Calgary.

The panel testing laboratory successfully met the annual recertification requirements of the Standards Council of Canada. Several runs of commercial panels passed through the laboratory including a preliminary panel produced by Pelican Spruce Mills Ltd. Tests were carried out in accordance with Canadian Standards Association and American Plywood Association standards for certification by Canada Mortgage and Housing Corporation. As a result, the panel produced by the new mill was accepted for use in housing construction.

The construction and testing of stress skin panels using Alberta-produced oriented strandboard continued. In particular, this included experiments to determine the effects of long-term loading.

In a project carried out for Western Archrib, substitution of Alberta wood for imported Oregon fir was successfully attained in the manufacture of glue-laminated beams. The result was improved commercial acceptance of the product both within and outside the province and increased consumption of locally produced lumber.

In the Forest Products Laboratory, Peter Taylor holds prototype sample of waveboard, developed at the Alberta Research Council.

Environment

Environmental Sensing and Modelling

Government and industry are increasingly concerned about environmental pollution, its detection and prevention. The only cost-effective way of addressing such concerns as deep waste injection or acid rain is through numerical models which can incorporate the enormous quantity of data required, and represent the complex physical processes over time in the particular environment. The Alberta Research Council is developing an environmental numerical modelling facility with the ultimate goal of providing industry with ready access to decision-making tools. This modelling facility will cover data collection, data processing and display, and eventually, expert systems.

In an initial project for Alberta Environment, researchers have acquired and implemented two regional-scale acid deposition models. These models are being applied to northern Alberta and Saskatchewan to study the impact of Athabasca oil sands plants on target loading with respect to lake and soil acidification. Another activity under the umbrella of the modelling facility is the processing of meteorological information collected during the Canadian Atlantic Storms Program. This processing required special upper air processing routines developed by the Alberta Research Council, and was carried out under contract to the Atmospheric Environment Service (AES).

AES is interested in the characteristics of aerosols (dust particles) in Western Canada. AES has contracted the Research Council to extract data on aerosols from the large data set collected during the Alberta hail project. From the extracted data, researchers derived vertical profiles of aerosol concentration and size in central Alberta. Under another AES contract, researchers are studying hail project data to characterize natural clouds in Alberta with respect to liquid water and ice crystal content, water and ice particle size and concentration.

Northwestern Utilities Limited is developing a gas operations support system, requiring software simulation of gas demand and flow in Northwestern Utilities' pipeline system for real time and forecast purposes. Under contract from Northwestern Utilities, the Research Council successfully completed a project to derive equations and predict current gas demand at unmonitored delivery points in the system, and to forecast future gas demand at both monitored and unmonitored delivery points, all based on usage patterns and environmental conditions.

The University of Dayton, in the United States, is obtaining icing information from various regions around the world at the request of the U.S. Federal Aviation Administration, which intends to update its standards for icing of aircraft. Under contract to the University of Dayton, the Research Council is surveying data collected from its research aircraft missions in order to calculate the potential severity of aircraft icing in summer and winter clouds.

The Research Council provided analysis software to Colorado State University which is developing special programs for analyzing its own research data.

Severe Weather

The Alberta Research Council is a leader in North America in the development of artificial intelligence (AI) systems for weather forecasting. This year, the Research Council completed a contract to integrate its severe weather forecasting expert system, METEOR, with PREFORMA, an AI system for weather analysis developed by MacDonald, Dettwiler and Associates Ltd., Richmond, B.C., to produce a Severe Weather Intelligent Forecast Terminal (SWIFT). SWIFT will give a forecaster a better indication of storm location, intensity and movement, and provide for more precise short-range (one to 48 hours) weather forecasts.

The International Development Research Centre has funded a McGill University project to provide and install a radar data processing system for the Lanzhou Institute of Plateau Physics, China. McGill contracted

the Alberta Research Council to provide this expertise to the project. Two Research Council scientists travelled to China to supply comparisons of the structure and evolution of hailstorms in Alberta to those in Gansu province, with the possibility of applying technology developed at the Alberta Research Council.

The Alberta Research Council has the only research weather radar data set containing thousands of hours of storm data with polarization diversity. The data contain evidence that polarization radar can distinguish between rain and hail. The University of Essex, England, has been working on the application of polarization data to communications problems in the United Kingdom and has purchased a package of the Research Council's data.

Basin Analysis

The recovery of oil from oil sands deposits in the Cold Lake area is based on steam injection methods, which require great amounts of water. The liquid wastes from these recovery processes are presently injected back into deep formations, mainly in the Mannville Group and Basal Cambrian Formation. In a project funded jointly with Alberta Environment, Alberta Research Council scientists used data from more than 15 000 wells over a 60 000-square kilometre area to simulate deep waste injection at given sites and known rates up to the year 2015. The simulations show no interference between injectors will occur. Water-rock interaction calculations for selected sites show that precipitation and dissolution of minerals will have a negligible effect on rock permeability and porosity. Researchers are studying the potential for formation fracturing and a future analysis of thermal effects of waste injection is being planned.

The results of these studies, to be published and presented at three international conferences, are being applied by Alberta Environment in establishing the water use and policy in the Cold Lake area. Government agencies (Alberta Environment, Environment Canada) and industry (Canadian Petroleum Association) are working to establish future directions of research to be performed by the Alberta Research Council in the field of deep waste disposal.

In addition to the geologic studies for AOSTRA's Underground Test Facility, an environmental feasibility study, funded by Environment Canada, has been started in which scientists will be looking at the impact of future oil recovery on the subsurface environment.

Water and Earth Resources

In a project jointly funded by the Alberta Heritage Savings Trust Fund and the Alberta Research Council, scientists are providing a scientific basis for development of guidelines for drilling-mud-solids-disposal that maximizes environmental safety and cost-effectiveness. A literature review and problem analysis of the effectiveness of geological containment of drilling waste in sumps was completed. Detailed sampling and characterization of wastes, resulting from freshwater gel, potassium chloride and sodium chloride mud systems currently used in the Cold Lake region, were undertaken to determine sampling design and analytical requirements for these wastes. Preliminary results of a greenhouse experiment to assess changes in growth and trace element content of vegetation as a function of different concentrations of wastes mixed with soil indicate both positive and negative impacts on the plants and soil.

In cooperation with Suncor, the Alberta Research Council continued the study of the feasibility of spreading a high-lime content sludge on land. Results of the field plot trials indicate the sludge is acting as a soil liming agent and does not produce any deleterious effects on the soil or crops.

A workshop organized by the Alberta Research Council and Alberta Environment to assess the effects of heavy metals on Alberta soils and soil waters was attended by private and public sector representatives. In response to the workshop's recommendations, the Alberta Research Council developed two analytical techniques for the

determination of the total elemental analysis of soils and plants. Assessments of soil impacts by current and predicted levels of acid deposition are being carried out for the Alberta Government/Industry Acid Deposition Research Program. Maximum acid loadings which can be tolerated by different soils are being determined by predictive modelling procedures in a related project with Alberta Environment.

Peatlands are being used increasingly in Alberta for agriculture, forestry, horticultural peat moss extraction and other uses. The drainage and clearing practices required for these uses can affect the water quality in drainageways emanating from peatlands. Chemical analyses of peat soils have been conducted in order to assist in the impact assessment of peatland development, particularly with regard to heavy metal contamination. This analytical information is being used, together with field data, to develop soil classification and mapping criteria which will assist in land use management decisions regarding peatlands. A peatlands distribution map for the province has been prepared. Research Council staff also helped organize an international Wetlands/Peatlands Symposium held in Edmonton.

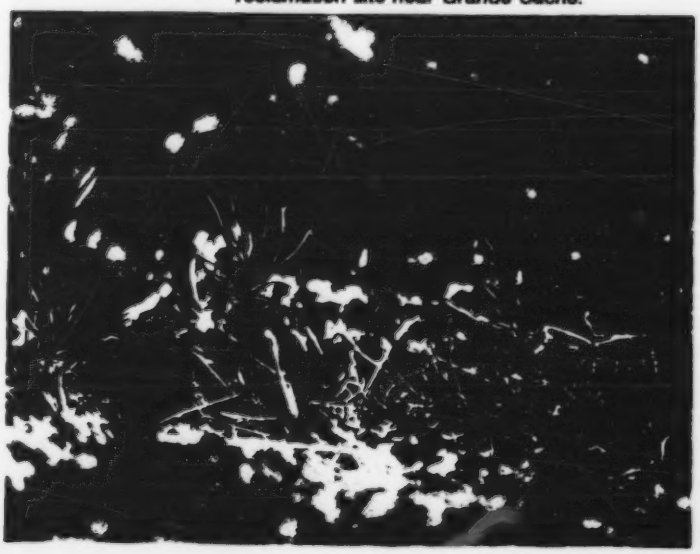
Land Reclamation

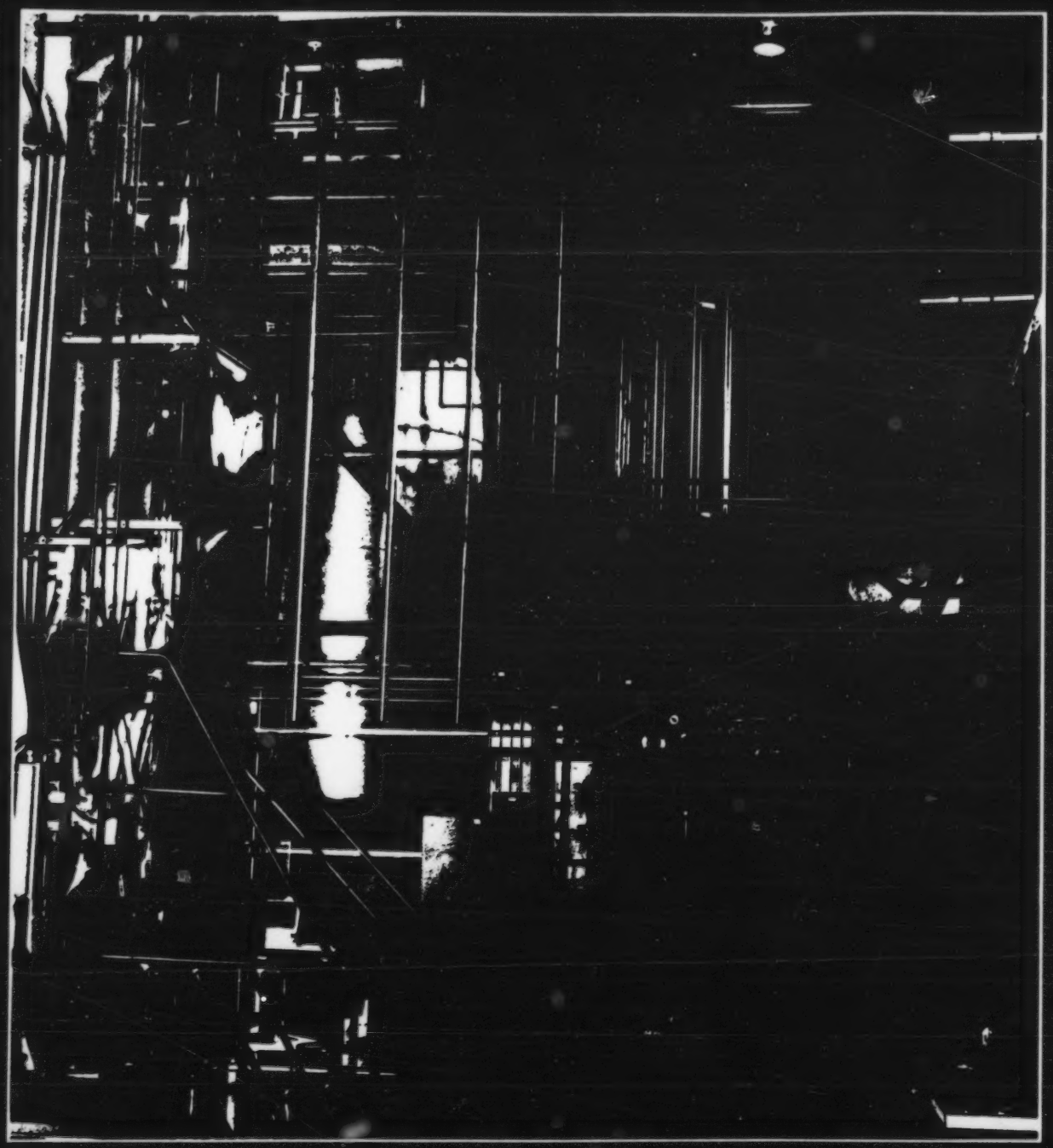
More than eight years of research on the hydrologic aspects of reclamation of surface coal mines in the plains of Alberta is now being published in a series of Research Council scientific reports. Researchers continued field-related assessment of the chemical and physical changes over time in reconstructed soils, the critical depths to water table and landscape settings that result in salinization, and the threshold characteristics of depth and duration of ponding that produce sufficient groundwater recharge to control the position of the water table.

At the Smoky River Coal Limited site near Grande Cache, scientists found that better germination and growth occur with directly seeded pine rather than spruce. They also found that grass, shrub and tree growth on spoil dumps was considerably better in areas where the surface soil contained coarse fragments, compared to areas where little, or no, coarse fragments were present.

Five years of research at the Luscar Ltd. Paintearth mine in east-central Alberta suggests that soils reconstructed after mining appear to have a capability for agriculture similar to soils prior to mining.

A year after planting, pine seedlings flourish at reclamation site near Grande Cache.





In the Biotechnology Pilot Plant, Pat Fung is dwarfed by the 7500-litre fermentor used in the scale up of microorganisms.

Biotechnology

The Alberta Research Council operates a biotechnology pilot plant to provide scale up and process development to preproduction levels for biotechnology companies seeking product development. Now in its second year of operation, the pilot plant has attracted national and international attention, and is considered one of the finest facilities of its type in North America. A 7500-litre fermentor, plus a 1500-litre fermentor and a series of smaller fermentors offer flexibility in pilot-scale work. A 15 000-litre fermentor, supported by its own downstream processing and other related equipment, was under construction in 1987 and will expand the pilot plant's capacity in product development.

One of the aims of the biotechnology program is to support the provincial government's effort in economic diversification by attracting new businesses to Alberta. Biosis Inc., a biological pest control company in Palo Alto, California, is now planning to build its own commercial plant in Alberta as a result of the preliminary work conducted at the Alberta Research Council in scaling up entomogenous nematode production; the product will be marketed as a biological insecticide to control a variety of garden pests such as grubs, wireworms and beetles.

Successful scale up of fish vaccines for netpen salmon has been developed by the Research Council for Microtek Research and Development Limited, Victoria, B.C. Results of the initial tests have prompted Microtek to seek Agriculture Canada licensing to use the Research Council's biotechnology pilot plant as a scale up facility and long-term supplier, and the company is now planning to open a branch in Edmonton to coordinate ordering, packaging and shipping of its products.

Vetrepharm Inc., London, Ontario, is actively engaged in the development and large-scale production of veterinary products for treatment of animal diseases. An initial contract for the development of a swine vaccine has been completed and further work on other animal vaccines is under way. The Research Council is conducting scale up work on a biological herbicide for PhilomBios Inc., of Saskatoon, Saskatchewan. A California company, Automedix Sciences, Inc., has contracted the Research Council to perform fermentation and subsequent purification of a required intracellular enzyme.

In cooperation with the National Research Council—Space Division, and SED Systems Inc., Saskatoon, the Alberta Research Council is conducting investigations which could lead to the development of a new fermentor for use in space. An apparatus to be used in an airborne laboratory to study how reduced gravity affects the way in which gas bubbles coalesce is being built at the Research Council, with engineering supplied by SED Systems. A Research Council scientist will take the apparatus on series of flights simulating space conditions aboard a NASA aircraft early in 1988.

Two grants from Alberta Agriculture's Farming for the Future program supported scale up and product development of the Research Council's long-term nitrogen fixing, nodule forming, *Rhizobium* innoculant program. In addition to this work, the funding also provides for production of exopolysaccharide and its use as a seed coating to increase the survivability of the *Rhizobium* on the seed.

Plant cell culture and fermentation projects have been performed for Plainsman Manufacturing Inc., Edmonton.

Agriculture

Soil and Water

Intense rainfall in the Vermilion area in August 1987 resulted in soil erosion totalling 100 to 200 tonnes of soil per quarter section on most summer fallow fields in the area. Such soil erosion is responsible for reduced soil quality and losses in crop productivity, but erosion is not confined to sudden storms. Research in measuring and modelling soil erosion in east-central Alberta has led to the conclusion that significant erosion occurs during rapid snowmelt in summer-fallowed fields. In a continuing study, researchers are using simulation modelling techniques to estimate erosion and deposition with time, based on rates measured in the field.

Researchers have made important contributions to solving the salinity problems facing dryland agriculture. In addition to continuing field studies near Carmangay and Forestburg, the Research Council has worked with Alberta Agriculture, the Prairie Farm Rehabilitation Administration, and Agriculture Canada, to improve the diagnosis and treatment of salinity. The Research Council has been instrumental in transferring technology to operational investigations, resulting in increased effectiveness through the use of soil profile characterization and hydrogeological instrumentation.

Steve Moran measures electrical conductivity in a patch of saline soil near Forestburg during a study of causes and treatment for soil salinity.

Natural Resources

Geographic Information Systems

An operational, microcomputer-based geographic information system (GIS) was developed for Alberta Forestry, Lands and Wildlife. This system, called "Recreation, Conservation Resources Information Systems" evaluates the recreation suitability of land in the agricultural areas of Alberta, on a quarter section basis, for 22 recreational activities. More than 300 000 quarter sections of land from south of Edmonton to the Montana border, are included in the evaluation. The work was done by a project team of Research Council staff and private sector consultants, resulting in considerable technology transfer to the private sector.

The Alberta Research Council, in cooperation with Alberta Municipal Affairs and on behalf of the Alberta Planning Board, is assessing the needs of regional planning commissions in Alberta for GIS technology, and developing a conceptual plan for its implementation.

The Alberta Research Council is assisting Champion Forest Products of Hinton, Alberta, in conducting a feasibility study for possible implementation of a GIS in operational forest management.

Industrial Minerals

Delineation and mapping of aggregate, one of the province's essential nonrenewable resources, is carried out by Alberta Research Council geologists under contract to Alberta Forestry, Lands and Wildlife. These data solve immediate resource problems and give provincial and municipal planners the information for managing the resource. This year, Alberta Research Council geologists used an exploration hypothesis that Tertiary gravel occurs at a certain elevation in the Chinchaga River area in northwestern Alberta. By aerial observation over the study area, they were able to identify the potential deposits at the elevation contours and confirm the hypothesis, as well as finding needed resources.

Through the International Development Research Centre, Ottawa, an Alberta Research Council geologist visited Guyana to provide geologic assistance in assessing clays and feldspar used in that country's ceramics industry.

Work was concluded on a project to evaluate potential sources of limestone for use as filler in the paper industry.

Land Resources

The multidisciplinary resource inventory of the County of Flagstaff, nearing completion, has become a model for expanded cooperation between the Alberta Research Council, Alberta Agriculture, Agriculture Canada and Alberta Environment, in building a uniform intermediate-scale, soils data base for agricultural counties in Alberta. With the initiation of a land resource inventory for the County of St. Paul, approximately one-quarter of the county was mapped this year.

The study of the Quaternary geology of southern Alberta integrates the mapping synthesis with the lithoanalysis of subsurface data. The project has resulted in production of two regional maps of surficial deposits in the southern half of the province, which can be used by geologists, environmental scientists, geotechnical companies and aggregate producers. The maps will be supplemented by a report on the composition and stratification of glacial drift.

In 1987, the Alberta Research Council and the Forest Research Branch, Alberta Forestry, Lands and Wildlife, initiated a jointly funded research project in forest soils. An analytical method has been developed for determining exchangeable cations in calcareous soils. Work related to determining what measures of soil have predictive value in terms of forest productivity is under way.

Industrial Assistance

Industrial Development

The Alberta Research Council administers the Industrial Research Assistance Program (IRAP) in Alberta for the National Research Council. IRAP encourages research and development activity, enabling small- and medium-size companies to undertake innovative projects they otherwise could not afford. In the past year, more than $3.5 million in IRAP funding, typically $6000 to a company, was dispensed.

Companies can call on a network of technology field advisors to assist in problem-solving. This year the field advisory service was extended with a permanent representative for Lethbridge and Medicine Hat in addition to offices in Edmonton and Calgary. A construction advisory service also was set up in cooperation with the National Research Council's field advisory service and the Institute for Research in Construction to provide the industry with technical assistance and information services.

Typical of the help provided to companies are the following examples:

Financial and technical assistance was provided through IRAP which has enabled Continental Down Hole Tools Ltd. to design and develop a new down hole tool for the oil drilling industry. This tool is a hybrid of two tools—the reamer stablizer and shock tool—incorporating the benefits of both. The product has been protected by a patent and field testing was scheduled for late 1987 in Texas. A company that was primarily a rental and servicing firm now has the capability to manufacture and market the new Stabi-Shock down hole tool with market potential that is global in scope.

Athabasca McEnterprises Ltd. identified a need, based on convenience and economic considerations of both the packaging industry and the private sector, for a reusable plastic closure for plastic bags used in food packaging. The material currently used for bag closures is polystyrene, with the advantage of low cost and high stiffness, but the disadvantage of brittleness which is aggravated under cold conditions. Technical and financial assistance was provided to the company for the formulation of a patented design of a foldable closure for flexible bags. The company was put in contact with the Northern Alberta Institute of Technology (NAIT) which was able to assist in the process development and hinge formation. Technical input from the Research Council was also provided to NAIT in the formulation of the plastic for the closure.

Through the International Technology Transfer program, the Research Council located a company in West Germany with the capability to manufacture the equipment for the composite of paper and plastic extrusion required for the foldable closures. The Athabasca firm is now in the process of purchasing the machine from West Germany and will establish a manufacturing plant in Athabasca for foldable plastic closures.

Hardy BBT Limited (formerly Hardy Associates (1978) Ltd.) received IRAP funding to make improvements in the hardware and software of a marine geophysical survey system to bring it to a commercially viable stage. This system offers resistivity, induced polarization, magnetics, sub-bottom profiling, and navigation techniques for mineral exploration, engineering and offshore applications. Achievements of the project include design and construction of a log-dipole cable for offshore applications, development of a computer model curve suite for interpretation of data, improvements in electrode design and refinements to navigation software. With successful completion of the project, the marine system was used commercially for mineral exploration in Ontario and Quebec during the summer and fall of 1987.

Industrial Technologies

The Alberta Research Council works with Alberta industries, the provincial and federal government departments in mission oriented research, development and testing. Specialized testing and analytical services offered in specific areas include polymers, chemicals, fuels and forest products. This

year, the various laboratories received more than 2500 enquiries from industry and individuals and responded directly to approximately one-half the requests on a cost-of-service basis. Enquiries also are referred to external laboratories or agencies where appropriate.

A start was made in the establishment of a materials research, development and testing section at the Alberta Research Council. Using established polymer testing capabilities as a base, a four-year joint research project with Esso Resources Canada Limited, Calgary, has been initiated to develop a pipe liner and placement technology for rejuvenating corroding pipelines subjected to multiphase flow.

Development of gas separation membranes continued through experiments designed to identify new membrane types and to improve the performance of existing membranes and gas separation systems. Staff participated in monitoring out-of-province field trials of gas separation modules which utilize the gas separating technology previously developed at the Alberta Research Council.

The Industrial Services Laboratory provided testing services to 150 small- and medium-size Alberta companies. In the work with larger companies, there was a shift toward services to the forest products sector, particularly in monitoring feedstock quality, research into resin quality and utilization, and the production of chemicals such as lignin from wood.

In support of the materials-related research, the Alberta Research Council has acquired a JEOL JSM 840A scanning electron microscope. This instrument is the most advanced of its type in Alberta and has features which will make it useful in the study of polymers, composites and ceramics. Initially the scanning electron microscope will be applied to the solution of problems involving the corrosion of pipelines and to study wear in highly stressed equipment such as downhole tools.

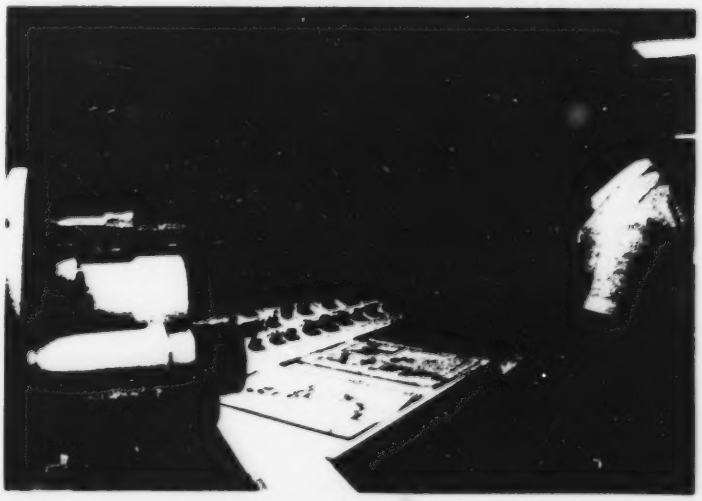
A unique system designed to spray new types of coatings on a wide range of materials in a vacuum has been purchased. This equipment will be applied to the pervasive problems of corrosion and wear in the energy and mining sectors.

Analysis and Testing

The Research Council offers a wide range of analytical services to industrial clients and the general public, as well as in-house support. The capability includes gas chromotography/mass spectrometry, inductively coupled plasma spectrometry, nuclear magnetic resonance, scanning electron microscopy, Fourier transform infra-red spectrometry, atomic absorption spectrometry and ultraviolet/visible spectrometry. Specialized analyses were conducted for individual clients when the required services could not be obtained commercially.

The Gasoline and Oil Testing Laboratory is engaged in a wide range of testing and inspection services in petroleum and related products, which include acting as a referee laboratory. In 1987, this laboratory obtained accreditation as a testing organization from the Standards Council of Canada. A survey of Canadian gasoline and diesel fuel characteristics was initiated in cooperation with nine petroleum companies and agencies across Canada.

Ed Zachurak operates new scanning electron microscope, a powerful analytical tool offering higher resolution than conventional units.



Alberta Research Council scientist Lynn Sutherland and David Jaques, D&S Knowledge Systems Inc., Calgary, discuss progress on a joint research project to develop an expert system for well log analysis. The new product, LOGMATE ASSISTANT, is being marketed by D&S.

Advanced Technologies

The Advanced Technologies Program, operating from the Research Council's Calgary offices, is gaining increased recognition for its research in the areas of artificial intelligence, distributed systems and robotics. In 1987 the Alberta Research Council became a founding member of a national precompetitive research and development consortium, PRECARN Associates Inc., formed by more than 30 companies and research institutes to promote and conduct research in artificial intelligence and robotics.

The number of contracts and activities associated with external clients, totalling $2.4 million, has more than doubled over the previous year. A $1 million, two-year agreement was signed with International Artificial Intelligence Corp., Toronto, Canada's leading private company in commercialization of products and services in artificial intelligence. Under the agreement, the Research Council will undertake contract research and development to support the firm's newly established presence in Alberta.

Specific projects conducted on behalf of industrial clients include expert systems for a variety of energy exploration applications, intelligent computer assisted instruction, hazardous materials management, and systems configurations. HERMES, an expert system prototype for hazardous materials management, has been developed in conjunction with Alberta Public Safety Services. This system is intended to assist teams of emergency workers who need rapid access to information such as weather conditions, location, population, type of hazardous material, and other factors needed to determine a course of action.

A pattern recognition system for the identification of handwritten characters has been undertaken on behalf of an Alberta industrial client. Several companies have benefitted from factory floor manufacturing investigations and identification of bottlenecks, and been shown more efficient processes. One Alberta company experienced a 50 percent increase in productivity simply by changing the way raw material is handled. An Alberta hospital has contracted for design equipment as part of a robot work cell which will be used to perform mundane and repetitive tasks. The equipment being designed has additional commercial potential.

Applied research in robotic technology which has potential application to Alberta industry is conducted at the Research Council. In the automation technologies laboratory, Henry Voss gives verbal commands to a robot to perform a set of tasks.

Joint Research Ventures

The Joint Research Venture program is an initiative of the Alberta Research Council to assist small- and medium-size Alberta companies in developing chosen technologies leading to marketable products. Launched five years ago, the Joint Research Venture program has been highly successful in the transfer of technology to Alberta's industries, with six projects completed and another five currently in operation.

The Research Council and PSI Energy Software Ltd. are developing a workstation, based on an IBM PC connected to a remote host, which will provide the oil and gas prospect analyst with an interactive system to collect, assemble and evaluate pertinent data quickly and effectively from distributed information sources. The system will bring a map room concept to the geologist's workstation.

In another project aimed at the energy industry, the Research Council and Western Geophysical Company of Canada Ltd. are jointly researching methods to improve the success rate and economic viability of miscible oil recovery. Computed tomography equipment and techniques are employed to examine cores to determine what happens when flooding is used to push the remaining crude to the surface.

With Pelorus Aviation Supplies (Canada) Ltd., of Calgary, researchers are designing a cost effective microwave landing receiver system for small- and medium-size aircraft. Another Calgary company, Standen's Limited, and the Research Council are engaged in a joint research venture to install a robot in Standen's vehicle springs manufacturing facility. The object is to design a workcell and select a robot to automate the task of removing hot spring steel from a furnace and place it in presses for forming.

A joint research venture with Computer Based Training Systems Ltd. (CBTS), Calgary, is developing a computer-managed learning system for use in the education field.

Joint research ventures with Veritas Software Ltd. for a Vertical Seismic Profile (VSP) system, and D&S Petroleum Consulting Group for an expert system in well log analysis, were completed this year. The prototype product for D&S shows such potential that a new company, D&S Knowledge Systems Inc., has been created with knowledge transferred from the Research Council through the joint research venture. A map editing workstation prototype, developed with Q.C. Data Collectors Ltd., gives the user a cost-effective method of editing complicated maps prior to their insertion into a permanent data base. Q.C. Data's Canadian and U.S. operations are using the system to advantage, with several demonstration sites in Calgary.

X-ray computed tomography is being used to examine oilfield cores in a joint research project between the Alberta Research Council and Calgary-based Western Geophysical Company of Canada Ltd. Dr. George Sedgwick views the CT images while John Woolley aligns a core in the scanner.

Transportation

Transportation Engineering

Alberta Transportation spends more than $100 million annually to pave the province's network of gravel roads. A variety of factors must be considered by decision-makers in assessing paving projects. These include construction costs, relative operating and maintenance costs and safety for highway users. In a joint research arrangement with Alberta Transportation and the University of Alberta, the Alberta Research Council is conducting technical and economic analyses of these factors to develop an assessment system to aid in priority planning of gravel road paving projects.

The majority of Alberta's paved roads are mature and more emphasis is being placed on developing design and evaluation procedures to address the questions of cost-effective maintenance procedures. Under the joint Alberta Research Council/Alberta Transportation program, engineers are using field data to develop improved methods for identifying the extent and severity of pavement deterioration caused by traffic and climate.

The Alberta Research Council has a representative on the advisory committee to the United States Strategic Highway Research Program and the Canadian counterpart. These bodies are laying the groundwork for the design of long-term pavement performance studies to be carried out in both countries.

The Alberta Research Council has received a subcontract from a United States engineering consultant to carry out field pavement testing using technology developed by Research Council engineers. Research Council staff will participate in the project beginning in early 1988.

Surface Water Engineering

Rivers exert an impact on their natural and man-made surroundings, especially in times of flood and during spring break up. Sediment transport, bed and bank scour, ice forces on bridge piers are some of the processes being studied to develop and improve both design guidelines and management techniques in water resources. The Alberta Research Council conducts studies in these areas for both Alberta Transportation and Alberta Environment.

Bed scour near piers and bridge abutments is a major concern for their design and licensing. The Research Council is completing analysis of scour data, collected over a 20-year period, to assess and improve current design guidelines. Sand-bed rivers—the Red Deer, Beaver, Swan and Battle—are the focus of current studies.

A major difficulty confronting bridge engineers is the measurement of ice forces on bridge piers during spring break up. Research Council engineers are completing a project to evalutate the use of accelerometers as inexpensive and portable load measuring devices. The results of this evaluation, as well as the ice force measurements obtained over the last three years from the Athabasca River at Hondo, will form the basis for revisions to bridge design standards.

Over the last 10 years, the Research Council has invested considerable resources in the geomorphic and hydrologic characterization of Alberta rivers near Water Survey of Canada stream flow gauges. This information is being used by the Research Council to update a 1972 publication, *Hydraulic and Geomorphic Characteristics of Rivers in Alberta,* a definitive guide for engineers and water resource managers. The new publication will cover rivers and streams not tabulated in its predecessor and provide more detailed information for all the rivers.

Electronics Test Centre

The Electronics Test Centre provides evaluation, testing and consultation services to electronics and telecommunications manufacturers to meet Canadian and international requirements. In its second year of operation the Test Centre continued to serve industry in Alberta while enlarging its operations to cover all of Canada. International marketing efforts were begun as well. At the end of 1987, the Test Centre had in hand 334 projects from 183 Alberta companies and 205 projects from 141 companies outside the province. The Test Centre is participating in the evaluation and integrity of new electronic systems under design for deployment to federal agencies and departments, including National Defence, RCMP, and Transport Canada.

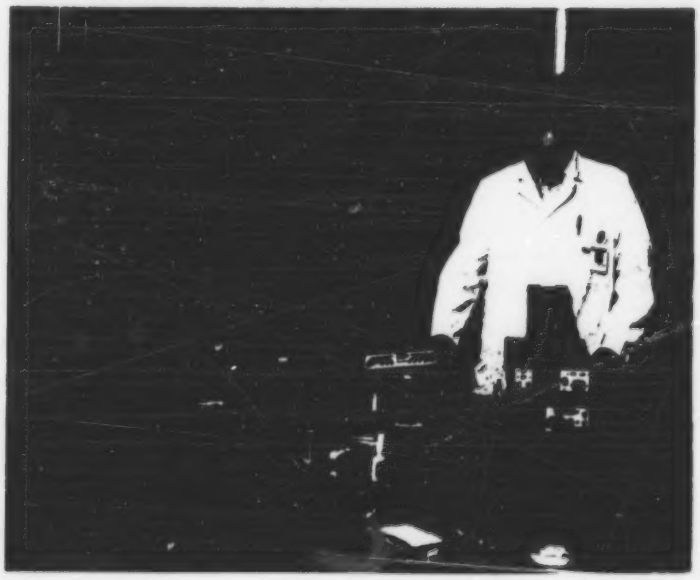
In 1987 the Electronics Test Centre obtained formal accreditation from the Standards Council of Canada and the Department of National Defence. The Test Centre is now a major component of the National Standards System in Canada and these formal recognition steps allow the Test Centre to participate in all areas of the electronics and telecommunications industries for both military and commercial clients. Before receipt of these accreditations, testing on behalf of Western Canadian companies was carried out at laboratories in Eastern Canada or in the United States. An accredited facility in Alberta will allow western companies to save time and money on defence products testing and approvals, and make their bids on DND tenders more competitive.

The Electronics Test Centre is a founding member of the Electronics Network of Alberta, a group of 14 high technology centres and institutes in the province, each one concentrating on a particular aspect of electronics technology. The network facilitates improved services to industry and governments through the exchange of information and ideas among its members.

IDACOM Electronics Ltd., Edmonton, a world leader in sophisticated portable testing equipment for the data communications industry, is a frequent user of the Test Centre's facilities. After IDACOM won a contract with Nippon Telephone and Telegraph of Japan, the Test Centre was able to test IDACOM'S product to Japanese standards and have these tests accepted by Japanese authorities, saving IDACOM time and money.

Another major client, NovAtel Communications Ltd., Calgary, has worked closely with the Test Centre in qualification testing of the company's cellular telephone products and systems. The resulting improvements in product integrity have led to acceptance of these products by the Ford Motor Company and the Government of the People's Republic of China.

In the Electronics Test Centre, Brian Bodley monitors vibration testing of equipment.



Information Centres

The Alberta Research Council operates information centres for the benefit of industry, government, the general public and staff.

Electronic Industry Information Centre

The Electronic Industry Information Centre, a pilot project of the Alberta Research Council, promotes new uses for remote information delivery of interest to the electronics industry. A primary objective is to ensure that Alberta's electronic and software industries are competitive and able to take advantage of anticipated growth in online business transactions.

The Electronic Industry Information Centre offers access to an electronic messaging service, a proprietary data base developed specifically for Alberta industry, and to international data bases. In 1987, a bulletin board for tendering opportunities from Alberta Public Works Supply and Services, was added on a pilot test basis.

Acceptance of the services is growing in the industry, and in 1987 the Electronic Industry Information Centre had more than 200 accredited users, double the number in 1986, the initial year of operation.

Alberta Waste Materials Exchange

An alternative to waste disposal and improved waste management practices is provided to Alberta industries through the Alberta Waste Materials Exchange (AWME). A project of the Alberta Research Council with funding from Alberta Environment, the AWME operates as an information clearing house designed to put potential users of waste materials in contact with waste producers. A company with waste material which still has potential value may list the material with the exchange. Information submitted is published in a bi-monthly bulletin without charge and mailed to other industries that may be able to recycle or reprocess the available materials.

In 1987 there were more than 296 companies actively participating in exchange with more than 450 different materials listed. One Edmonton silver recovery firm, after extracting the silver from more than one million pounds of waste photographic film, eliminated the problem of having to landfill or stockpile the processed film. The Alberta Waste Materials Exchange was able to put the company in contact with a plastics recycling firm in Innisfail, and with another firm in Edmonton using the material in a process to remove paint from automobiles. The company also credits the AWME with increasing its profile in the waste management and recycling field in Alberta.

Industrial Information

Industrial Information Services in both Edmonton and Calgary provide industry with a direct link to more than 95 percent of the world's published scientific and technical literature in data bases from Canada, the United States and Europe.

The capability of voice/data conferencing offered through Telecom Canada's iNet 2000 network allows for telephone and computer terminal links, enabling an information specialist and client to share the same information on their terminal screens during an online literature search. Additional terminal telephone/computer links to the conference enable scientific and technical experts to be part of the information search and delivery process. An important advantage to clients is the ability to capture the search results at their location. Over the past year many companies have used this service and realized the benefits of voice/data conferencing.

Industrial Information carried out close to 1800 online searches for Research Council technology advisors and industrial clients seeking information on topics as diverse as water slides and CADD technology. From the search results provided, more than 2200 documents were ordered and delivered to clients.

Information Geology

Information Geology handles an average of 500 inquiries annually. In addition to managing GEODIAL, the provincial geological data base, Information Geology manages geological assessment reports, records of mineral drilling in Alberta, and economic mineral files. It also contributes information to the national bibliographic data base under a data transfer system between GEODIAL and GEOSCAN, the national data base. Information Geology is being broadened to include a marketing component for the Alberta Geological Survey.

AOSTRA Library and Information Services

The AOSTRA Library and Information Services (ALIS) is the central source of all published information on oil sands and heavy oil as well as selected publications on enhanced recovery processes. ALIS is totally funded by the Alberta Oil Sands Technology and Research Authority, and managed by the Alberta Reseach Council. This year, the library opened a Calgary office.

ALIS maintains four confidential data bases: the AOSTRA/Alberta Research Council Access Program, the AOSTRA University Research Program, the AOSTRA/Industry Field Pilots and the AOSTRA Mining Extraction and Upgrading Program.

Information specialist Karon Tolonen discusses results of an online data base search for Walter Cool, construction technology advisor in the Industrial Development Department.

Patents and Publications

Patents

Alkali recycling process for recovery of heavy oils and bitumens, Canada 1129801, USA 4409091
Kessick, M.A.

Apparatus for progressively removing layers of overburden from an inclined side of a cut, Canada 1064059
Owen, H.D. and T. Smith

Apparatus for the manufacture of a corrugated waferboard panel, USA 4616991
Bach, L. and E. Stark

Arc welding, Canada 1090427, USA 4295031
Roen, R.A.

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Jensen, E.J. and L.M. White

Beneficiation process for oxidized iron ore, Canada 1125030
Bertram, E.F. and P. Harris

By-pass system for transporting pipelined solid bodies around pumps, Canada 840880, Canada 840881, Canada 841486, USA 3339984
Berkowitz, N., R.A.S. Brown, E.J. Jensen and C. De Zeeuw

Coal liquefaction process with oil sand bitumen derived solvent, Canada 1160586
Moschopedis, S.E.

Combination solvent injection-electric current application method for establishing fluid communication through heavy oil formation, Canada 1166151, USA 4450909
Sacuta, A.

Composition of matter convertible to stable metallic form by hydrogen reduction, Canada 768095, USA 712302
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Desulfurization of fluid coke, Canada 1098464
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Extraction of oil from bituminous sands, Canada 448231
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Formation of coke from heavy crude oils in the presence of calcium carbonate, Canada 1156952, USA 4521382
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Kessick, M.A., Z.M. George and L.G. Schneider

Method and apparatus for direction of solid bodies in pipeline transportation, Canada 843824, USA 3556604
Round, G.F.

Method and apparatus for pumping mixtures, Canada 809110, USA 3325222
Hodgson, G.W., A.A. Roehl and M.E. Charles

Method and apparatus for transporting package material in a pipeline, Canada 673280, USA 3333901, USA 3328089
Hodgson, G.W. and M.E. Charles

Method of feeding ruminants N-Glucosyl-N'-Hydroxymenthyl-urea, USA 3843799
Elofson, R.M., L.P. Milligan, J. Wohllebe and M. Worsley

Method of preparation of coal for safe transport and storage, Canada 959783
Berkowitz, N. and J.G. Speight

Method of transporting a substance along a pipeline, Canada 881986, USA 3633976
Kruyer, J.

Method of transporting oil and natural gas along a pipeline, Canada 973775, USA 3906972
Jensen, E.J., R.A.S. Brown and E.J. Wiggins

Oil sands mining, Canada 519731
Currie, D.J. and M.A. Kessick

Pipeline transportation of suspensions of subdivided solids, Canada 702627
Berkowitz, N. and C. Moreland

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Regeneration process for poisoned Claus alumina catalyst, Canada 1097317, USA 4183823
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Financial statements

ALBERTA LEGISLATURE
OFFICE OF THE AUDITOR GENERAL

Auditor's Report

To the Board of Directors of
the Alberta Research Council

I have examined the balance sheet of the Alberta Research Council as at March 31, 1987 and the statement of revenue, expenditure and equity for the year then ended. My examination was made in accordance with generally accepted auditing standards, and accordingly included such tests and other procedures as I considered necessary in the circumstances, except as explained in the following paragraph.

As disclosed in Note 4 to the financial statements, the Council has entered into research contracts which specify that the Council does not receive title to fixed assets purchased until completion of the contract or at the discretion of the sponsor. Since the Council did not identify those fixed assets to which it may not have title, I was unable to determine if any adjustment might be required to the balance sheet to adjust fixed assets and fixed assets equity to reflect ownership of the assets.

In my opinion, except for the effect of adjustments, if any, which I might have determined to be necessary had I been able to identify assets to which the Council may not have title as described in the preceding paragraph, these financial statements present fairly the financial position of the Council as at March 31, 1987 and the results of its operations for the year then ended in accordance with the disclosed basis of accounting, considered appropriate in the circumstances, as described in Note 2 to the financial statements applied on a basis consistent with that of the preceding year.

Donald D. Salmon

C.A.
Auditor General

Edmonton, Alberta
July 17, 1987

Alberta Research Council Balance Sheet as at March 31, 1987

(thousands of dollars)

Assets	1987	1986
Current:		
Cash	$ 9,618	$10,992
Accounts receivable	3,514	5,042
Accrued income receivable	1,922	2,081
Prepaid expenses	45	25
Advances to joint ventures	410	624
	15,509	18,764
Non-current:		
Investment in limited partnership (Note 3)	200	200
Fixed:		
Equipment (Note 4)	43,717	37,014
	59,426	55,978
Trust Fund:		
Cash	116	180
	$59,542	$56,158
Liabilities and Equity		
Current:		
Accounts payable	$ 4,269	$ 3,202
Unearned contract revenue	2,384	938
Promissory note payable (Note 3)	200	100
Obligation under capital lease (Note 6)	502	-
	7,355	4,240
Non-current:		
Unearned contract revenue	1,230	1,100
Obligation under capital lease (Note 6)	1,093	-
Promissory note payable (Note 3)	-	100
	2,323	1,200
Equity:		
Fixed assets (Note 5)	42,122	37,014
Operating	2,354	6,502
Special purpose, Schedule I	5,272	5,486
Capital reserve	-	1,536
	49,748	50,538
	59,426	55,978
Trust Fund:		
Trust liability	116	180
	$59,542	$56,158

The accompanying notes are part of these financial statements.

Alberta Research Council Statement of Revenue, Expenditure and Equity for the year ended March 31, 1987

(thousands of dollars)

Revenue	Operating	Special Purpose (Schedule I)	Total 1987	Total 1986
Grants from Province of Alberta:				
General Revenue Fund	$19,020	$3,810	$22,830	$26,209
Alberta Heritage Savings Trust Fund	-	565	565	1,385
	19,020	4,375	23,395	27,594
Contract revenue	15,943	261	16,204	21,251
	34,963	4,636	39,599	48,845
Expenditure				
Natural resources	11,148	-	11,148	12,580
Energy resources	11,139	-	11,139	11,229
Applied sciences	5,826	1,062	6,888	6,965
Industrial and engineering research	4,823	1,070	5,893	3,784
Finance and administration	4,966	-	4,966	4,163
Executive offices	2,456	-	2,456	1,178
Millwoods/Devon fitting up	-	825	825	2,760
Electronics Test Centre	-	2,182	2,182	6,092
Office of Science and Technology	-	-	-	196
	40,358	5,139	45,497	48,947
Deficiency of revenue over expenditure for the year	(5,395)	(503)	(5,898)	(102)
Equity at beginning of year	6,502	5,486	11,988	13,626
	1,107	4,983	6,090	13,524
Transfer	(170)	170	-	-
Transfer (to) from capital reserve	1,417	119	1,536	(1,536)
Equity at end of year	$ 2,354	$ 5,272	$ 7,626	$11,988

Alberta Research Council

Notes to the Financial Statements

March 31, 1987

Note 1 Authority

The Alberta Research Council operates under the authority of the Alberta Research Council Act, Chapter A 35.1, Statutes of Alberta 1981.

Note 2 Summary of Significant Accounting Policies and Reporting Practices

(a) General

These financial statements have been prepared in accordance with generally accepted accounting principles except that purchases of fixed assets are charged to operations in the year of acquisition. Notwithstanding this policy however, fixed assets are shown on the balance sheet at original cost, or at estimated cost, with the offsetting credit to fixed assets equity.

(b) Capital Leases

Assets acquired under capital leases, which transfer substantially all the benefits and risks incident to ownership of the assets, are initially recorded as fixed assets at cost and the related lease obligations are recorded as liabilities. Operations are charged with the capital portion as lease payments are made.

(c) Advances to Joint Ventures

Advances to joint ventures are recorded as assets of the Council. The asset is reduced and a corresponding charge is made to expenditure for the Council's share of joint venture expenses.

(d) Patents

Expenditures for patents owned by the Council as a result of research activity are not capitalized due to the intangible nature of assets that may accrue to the Council.

(e) Contract Revenue Recognition

Contract revenue is recognized as costs are incurred, up to the contract maximum and in accordance with contracted cost sharing ratios. In accordance with generally accepted accounting principles, the Council makes full provision for all known or estimated losses on uncompleted contracts as soon as they can reasonably be estimated. Accordingly, revenue is deferred to future years and matched against costs incurred to complete the project.

(f) Investment

The Council is a minority shareholder of International Permeation Inc. The equity allocated to Council was based upon the technological "know how" acquired by International Permeation Inc. from a former company to which Council provided research and technological expertise and was the majority shareholder.

The Council's equity in the company is not reflected in these financial statements due to the intangible nature of the benefits which may accrue to the Council.

(g) Special Purpose Equity

Special purpose equity is to be used only for future expenditures related to those activities listed on Schedule I.

(h) Trust Liability

Trust funds are contributions received from other government departments under research agency agreements which specify the Council administer the contributions and provide accounting services.

(i) Changes in Financial Position

A statement of changes in financial position is not provided as disclosure in these financial statements is considered to be adequate.

Note 3 Investment in Limited Partnership

The Council has purchased one limited partnership unit in Spurt Investment Fund I, a venture capital fund designed solely to make equity investments in seed and early stage technology enterprises. The partnership unit which cost $300,000, was acquired with a payment of $100,000 and a non-interest bearing promissory note requiring payments of $100,000 on each of October 27, 1986 and 1987. The October 27, 1986 payment was not made at the request of the partnership and is now payable upon demand.

As it is uncertain if any benefits will accrue to the Council, the investment is being written off as payments are made. The amount of the investment is summarized as follows:

	1987	1986
Original cost	$300,000	$300,000
Less: Amount written off	100,000	100,000
Book value	$200,000	$200,000

Note 4 Fixed Assets

Fixed assets purchased subsequent to April 1, 1981 have been valued at cost. Those purchased prior to April 1, 1981 have been valued at estimated cost by the Council.

Included in fixed assets are certain fixed assets purchased as a result of research contracts which specify that the Council does not receive title to the fixed assets purchased until completion of the contract or at the discretion of the sponsor.

Note 5 Fixed Assets Equity

	1987	1986
Balance at beginning of year	$37,014,483	$27,208,354
Add: Additions at cost	7,132,763	10,176,796
	44,147,246	37,385,150
Less:		
Obligations under capital lease	1,594,919	-
Disposals at cost	430,011	370,667
Balance at end of year	$42,122,316	$37,014,483

Note 6 Obligation Under Capital Lease

Year ending March 31, 1988	$650,220
1989	650,220
1990	596,035
	1,896,475
Less: Interest	301,556
	1,594,919
Current portion	501,893
	$1,093,026

Note 7 Obligations Under Operating Leases

Year ending March 31, 1988	$225,280
1989	189,161
1990	116,787
1991	61,945
1992	47,892
	$641,065

Note 8 Occupancy and Office Furniture Expenditure

Occupancy and office furniture have been provided by the Province of Alberta at no cost and are not reflected in these financial statements.

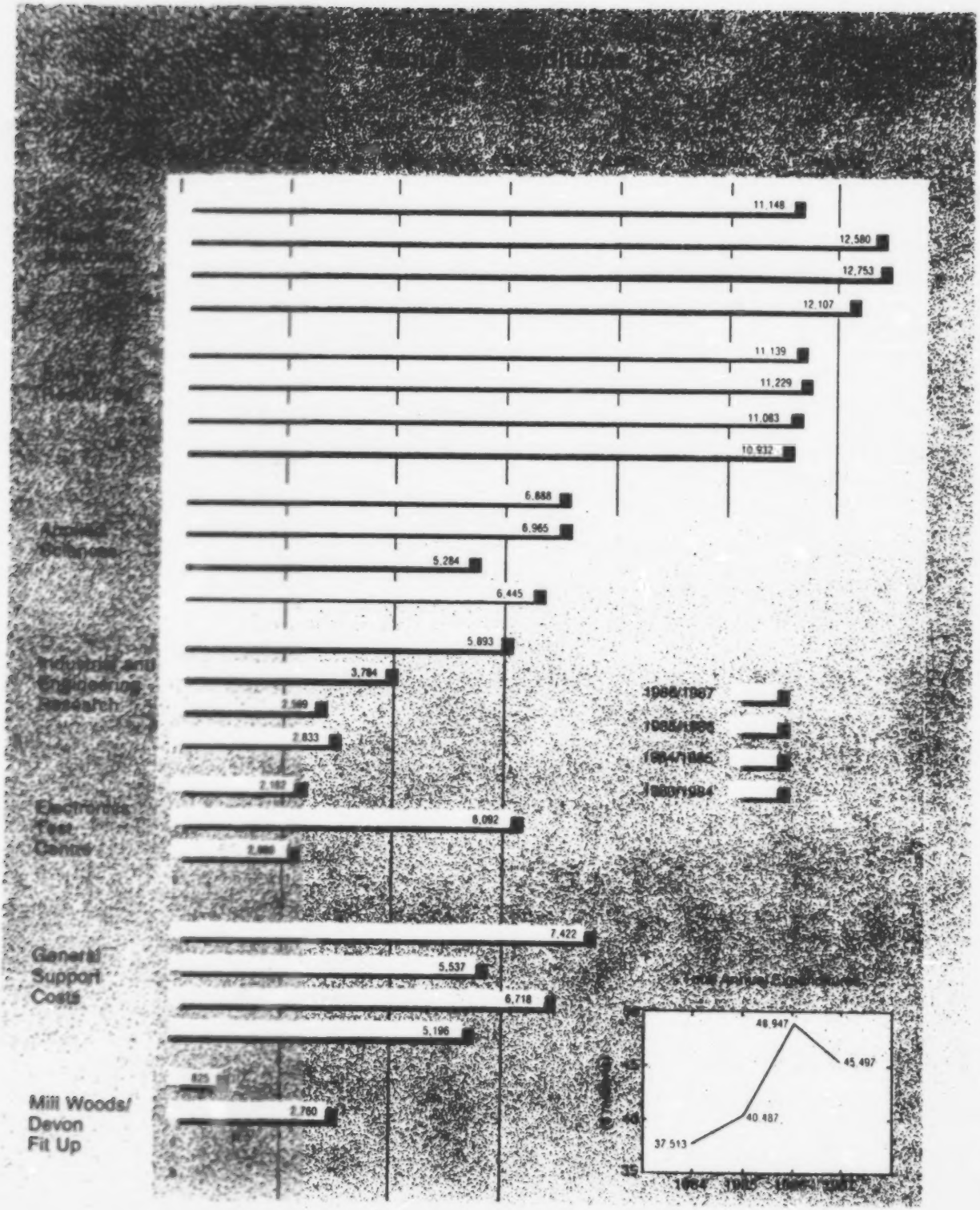
Note 9 Approval of Financial Statements

These financial statements were reviewed by management and recommended to the Board for approval.

Alberta Research Council
Schedule of Special Purpose Revenue, Expenditure and Equity
for the year ended March 31, 1987

Schedule 1

	Electronics Test Centre	Office of Science & Technology	Joint Research Venture Initiatives	Millwoods/ Devon Fitting Up	Electronic Industry Information Centre	Bio-technology Toll Facility	Total 1987	Total 1986
Revenue								
Grants from Province of Alberta:								
General Revenue Fund	$ 305,000	$ -	$ -	$1,000,000	$ -	$2,505,000	$3,810,000	$7,482,000
Alberta Heritage Savings Trust Fund	565,000	-	-	-	-	-	565,000	1,385,000
Contract revenue	254,987	-	-	-	6,034	-	261,021	72,090
	1,124,987	-	-	1,000,000	6,034	2,505,000	4,636,021	8,939,090
Expenditure								
Manpower	767,010	-	-	-	110,408	12,928	890,346	654,773
Supplies and services	851,946	97	984,291	-	230,486	192,454	2,259,274	2,064,871
Fixed assets	407,030	-	-	824,327	16,200	585,525	1,833,082	6,940,191
Overhead	156,191	-	-	-	-	-	156,191	91,736
	2,182,177	97	984,291	824,327	357,094	790,907	5,138,893	9,751,571
Excess (deficiency) of revenue over expenditure for the year	(1,057,190)	(97)	(984,291)	175,673	(351,060)	1,714,093	(502,872)	(812,481)
Balance at beginning of year	1,331,275	181,322	1,366,578	2,034,476	572,226	-	5,485,877	6,298,358
Transfer (to) from operating equity	-	-	-	(880,000)	-	1,050,000	170,000	-
Transfer from capital reserve	-	-	-	-	-	119,000	119,000	-
Transfer	-	-	271,110	-	-	(271,110)	-	-
Balance at end of year	$274,085	$181,225	$653,397	$1,330,149	$221,166	$2,611,983	$5,272,005	$5,485,877


11,148
12,580
12,753
12,107
11,139
11,229
11,083
10,932
6,888
6,965
5,284
6,445
5,893
3,784
2,599
2,833
2,182
8,092
7,422
5,537
6,718
5,196
825
2,760
Mill Woods/
Devon
Fit Up
General
Support
Costs
Electronic
Test
Centre
Industrial and
Engineering
Research
Abattoir
Activities
1986/1987
1985/1986
1984/1985
1983/1984
48,947
45,497
40,487
37,513
45
40
35

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DR. C.W. BOWMAN*
President, Alberta Research Council, Edmonton

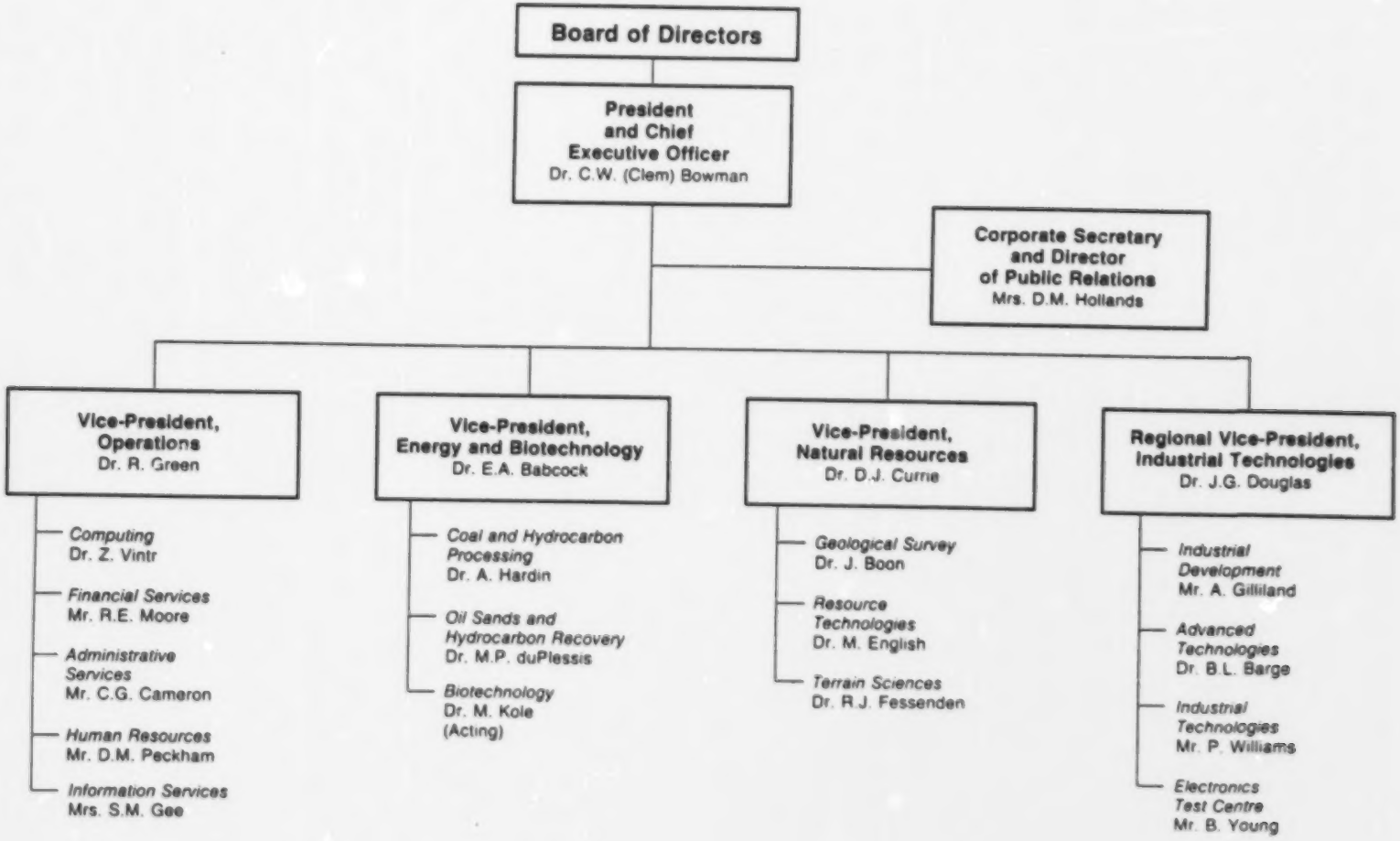
Directors who have made major contributions to the Alberta Research Council and who retired in 1987:

DR. J. G. KAPLAN, also retired as Vice-President (Research), University of Alberta. Dr. Kaplan was subsequently appointed a Research Fellow to the Alberta Research Council.

DR. R.W. STEWART, on his retirement as President, Alberta Research Council.

*Executive Committee
**Electronics Test Centre Management Committee

Alberta Research Council Organization Chart*



*1 December, 1987

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